Fiscal Year:	FY 2015	**Task Last Updated:**	FY 04/16/2015
PI Name:	Bloomberg, Jacob J. Ph.D.		
Project Title:	Physiological Factors Contributing to Postflight Changes in Functional Performance (Functional Task Test)		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
Joint Agency Name:	**TechPort:**		No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Sensorimotor**:Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Houston	**State:**	TX
Zip Code:	77058-3607	**Congressional District:**	36
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	Directed Research
Start Date:	06/19/2008	**End Date:**	11/30/2014
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	2	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	1	**Monitoring Center:**	NASA JSC
Contact Monitor:	Norsk, Peter	**Contact Phone:**	
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Flight Program:	Shuttle/ISS		
Flight Assignment:	ISS NOTE: End date changed to 11/30/2014 per HRP information (Ed., 3/31/15) NOTE: Gap changes per IRP Rev E (Ed., 3/18/14) NOTE: End date changed to 5/5/2015 and Risk/Gaps changed per JSC MTL dtd 11/11/11 (Ed., 11/18/2011) NOTE: End date changed to 3/17/2014 (previously 9/30/13) per JSC (2/2010)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Feiveson, Alan (NASA Johnson Space Center) Lee, Stuart (Wyle Laboratories/NASA Johnson Space Center) Mulavara, Ajitkumar (USRA) Peters, Brian (Wyle Labs/NASA Johnson Space Center) Platts, Steven (NASA Johnson Space Center) Reschke, Millard (NASA Johnson Space Center) Ryder, Jeffrey (USRA) Spiering, Barry (Wyle Labs/NASA Johnson Space Center) Stenger, Michael (Wyle Labs/NASA Johnson Space Center) Ploutz-Snyder, Lori (USRA) Tomilovskaya, Elena (Institute of Biomedical Problems) Kozlovskaya, Inessa (Institute of Biomedical Problems)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			
Task Description:	Exposure to the microgravity conditions of spaceflight causes astronauts to experience alterations in multiple physiological systems including sensorimotor disturbances, cardiovascular deconditioning, and loss of muscle mass and strength. Some or all of these changes might affect the ability of crewmembers to perform critical mission tasks immediately after landing on a planetary surface. The goals of the Functional Task Test (FTT) study were to determine the effects of spaceflight on functional tests that are representative of critical exploration mission tasks and to identify the key physiological factors that contribute to decrements in performance. The FTT was comprised of seven functional tests and a corresponding set of interdisciplinary physiological measures targeting the sensorimotor, cardiovascular and muscular adaptations associated with exposure to spaceflight. Both Shuttle and International Space Station (ISS) crewmembers as well as bed rest subjects participated in this study. Spaceflight data were collected in three sessions before flight, on landing day (Shuttle only), and 1, 6, and 30 days after landing. Bed rest subjects were tested three times before bed rest, immediately upon getting up after 70 days of 6° head-down bed rest, as well as 1, 6, and 12 days during the subsequent re-ambulation period. The bed rest analog allowed us to isolate the impact of body unloading without other spaceflight environmental factors on both functional tasks and on the underlying physiological factors that lead to decrements in performance, and then to compare those results with the results obtained in our spaceflight study. Information obtained in this study will inform the design and implemention of countermeasures that specifically target the physiological systems most responsible for the altered functional performance associated with spaceflight.		
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research, which requires focused and constrained data gathering and analysis that is more appropriately obtained through a non-competitive proposal.		

Research Impact/Earth Benefits:	This study will identify which physiological systems contribute the most to impaired performance on mission critical functional tasks. This will allow us to identify the physiological systems that play the largest roles in decrements in overall functional performance. Using this information we can design and implement countermeasures that specifically target the physiological systems most responsible for the altered functional performance associated with spaceflight. In terms of Earth benefits this research will provide a better understanding of the underlying physiological mechanisms that contribute to changes in functional performance. For example, in the elderly population activities of daily living are often impaired by mutifactorial physiological causes. The information obtained from this interdisciplinary study will aid in identifying the relative contributions of sensorimotor, cardiovascular, and muscle function on comprehensive performance outcomes. This has direct application in the design of clinical interventions and rehabilitation programs that can target specific systems responsible for decline in functional performance.
Task Progress:	We have shown that for Shuttle, ISS, and bed rest (control and exercise) subjects, functional tasks requiring a greater demand for dynamic control of postural equilibrium (i.e., fall recovery, seat egress/obstacle avoidance during walking, object translation, jump down) showed the greatest decrement in performance. Functional tests with reduced requirements for postural stability (i.e., hatch opening, ladder climb, manual manipulation of objects, and tool use) showed little reduction in performance. These changes in functional performance were paralleled by similar decrements in sensorimotor tests designed to specifically assess postural equilibrium and dynamic gait control. The muscle function data showed reductions in lower body muscle performance metrics in both spaceflight groups and bed rest subjects who did not exercise. Bed rest subjects who performed an integrated high intensity interval-type resistance and aerobic training program while in bed showed significantly improved lower body muscle performance compared to bed rest controls and spaceflight subjects. However, resistive and aerobic exercise alone was not sufficient to mitigate decrements in functional tasks that require dynamic postural stability and mobility and point to the need for the addition of balance training to current in-flight countermeasures. Bed rest subjects experienced similar deficits both in functional tests with balance challenges and in sensorimotor tests designed to evaluate postural and gait control as spaceflight subjects indicating that body support unloading experienced during spaceflight plays a central role in post-flight alteration of functional task performance. Additionally, ISS crewmembers who walked on the treadmill with higher pull-down loads had enhanced post-flight performance on tests requiring mobility. Taken together the bed rest and in-flight exercise training data point to the importance of providing increased body loading during in-flight treadmill and lower body resistive exercise. Both spaceflight and bed rest data indicate that an elevated heart rate was required to maintain arterial blood pressure during performance of multiple functional tasks. Spaceflight data indicated that restoration of plasma volume alone did not prevent the elevated heart rate experienced while prone or standing during postflight testing. These data indicate that additional countermeasures are necessary to maintain central blood volume, prevent or reverse changes in peripheral vasoconstriction, and minimize the need for elevations in heart rate during various functional tasks. These data demonstrate that an integrated countermeasure system should be composed of the following elements: 1) A high intensity interval-type resistance and aerobic exercise training program, 2) Balance/sensorimotor adaptability training, and 3) Individualized gradient compression garments (GCG) coupled with pre-landing fluid loading. Forward work will focus on follow-up bed rest and flight studies that incorporate these elements into an integrated interdisciplinary countermeasure system for future exploration class missions.
Bibliography Type:	Description: (Last Updated: 05/21/2021)
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